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Ministry
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Environment

FACTS

FOR ENVIRONMENTAL STUDIES

ABOUT THE ENVIRONMENT...



AIR POLLUTION AND WEATHER

GEOGRAPHY AND THE COMMUNITY

POLLUTION IN THE GREAT LAKES

INVESTIGATING ENVIRONMENTAL
HABITATS

set 5

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FACTS

FOR ENVIRONMENTAL STUDIES



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AIR POLLUTION AND WEATHER

Students from grade school to college know that weather has something to do with air pollution. Many associate buildups of air pollution with terms like inversion or stagnant. Yet students, teachers, and the general public are confused as to how weather conditions affect air quality. Some of these conditions can be simulated in activities easily carried out in science laboratories and classrooms.

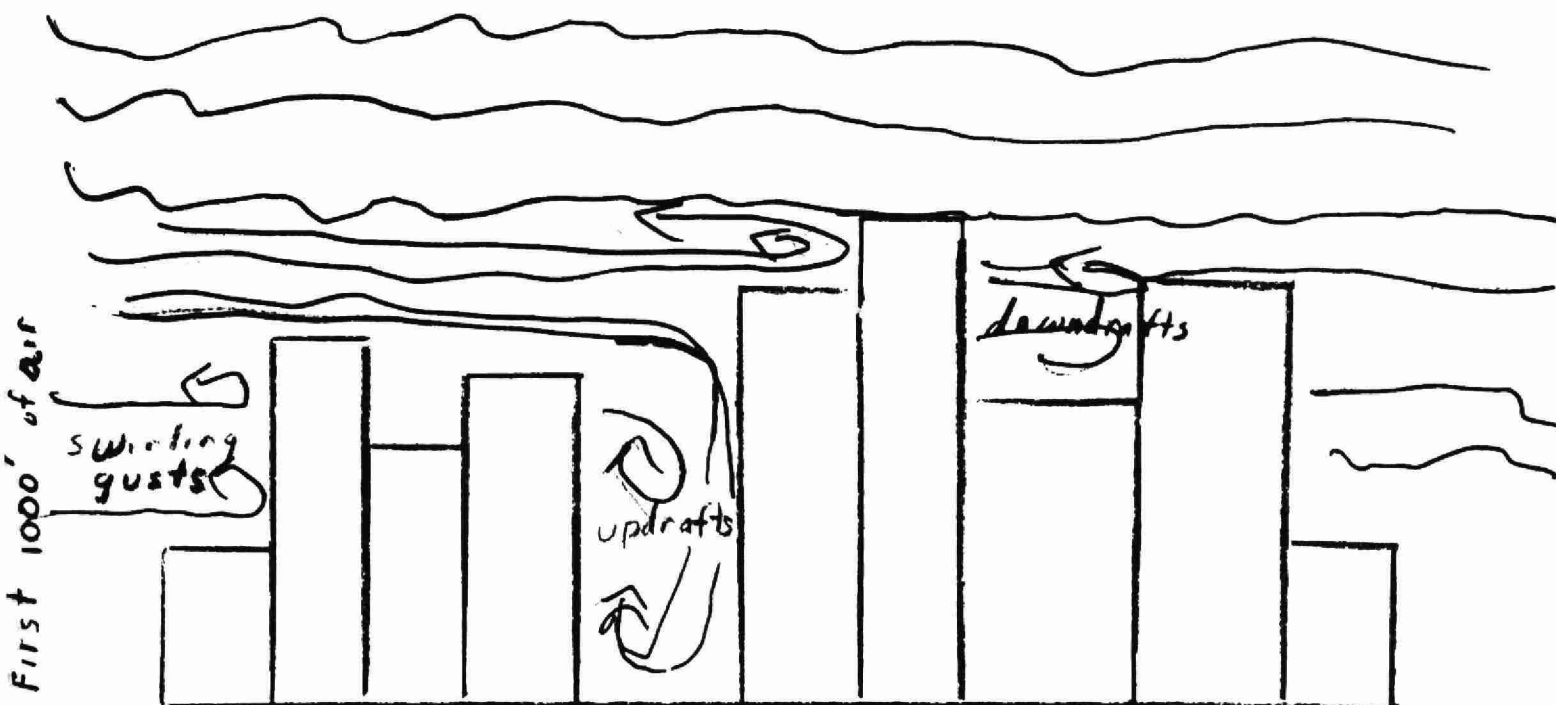
Atmospheric Motion, Dispersion, and Air Pollution:

In our urban areas we rely (too greatly) on atmospheric motions to disperse or dilute the enormous load of pollutants emitted from cars, factories, power plants, incinerators, homes, open burning, and many other sources. Dispersion is a process by which pollutants are transported from a region of high concentration to a region of low concentration. Students will get the idea very quickly if the instructor makes a cloud of cigarette smoke in front of the class. Concentrated at first and quite visible, the tiny smoke particles soon mix into larger and larger volumes of air. After a minute or so the particles spread apart so that they are no longer visible.

The rate of dispersion of the smoke is dependent on the motion of the air within the room. If the air is very still, the mixing or dilution process will be slow. If the students in the room move about, they will create turbulent motions of the air, and the rate of smoke dispersion will increase. Open windows or exhaust fans in the room and ventilation currents may also aid in the dissipation of the smoke cloud.

Let's move from the classroom to the urban atmosphere. On certain days atmospheric motions are strong, and dispersion of air pollutants is rapid. The air is relatively clean. At other times the atmosphere is calm, dispersion is slow, and pollutants may build up to serious levels. In certain cases conditions may persist for days on end, resulting in so-called air pollution episodes. But what factors make the difference between good and poor dispersion? Why is the air fresh and clean on some days and smog-ridden on others? To get a fairly complete picture, we must consider two factors. First, the wind (horizontal movement), and second the effect of vertical motions of the atmosphere. The effect of wind is easily grasped by students. They can picture the wind blowing away the pollutants (let the folks downwind suffer!). As a rough rule of thumb, pollutant concentrations are inversely proportional to wind speed. If wind speed doubles, pollution levels will be halved.

The role of vertical motions on dispersion is a new concept to most students. Figure 1 illustrates how vertical mixing results in upward transfer of pollutants.



The diagram shows the air in the first several thousand feet to be turbulent; the flow is not smooth and horizontal but is characterized by swirling gusts, updrafts, and downdrafts. These turbulent motions are caused by the roughness of the urban land surface. The irregular topography of small and tall buildings separated by streets broad and narrow, promotes the drafts and downdrafts shown in picture 1. Temperature variations (hot and cold spots) on the urban surface also promote turbulent vertical motions.

These vertical motions are extremely important in the dispersion of pollutants emitted from the urban area. Upward motions carry polluted air away while downward motions carry relatively cleaner air downward toward the surface. The net result of both upward and downward motions is an upward transfer of pollutants (away from the breathers). It follows logically that atmospheric conditions that promote deep vertical mixing will enhance the upward transport of pollutants. These actions which retard vertical turbulence will reduce the dispersion process.

The most important factor in determining the rate of vertical mixing is the way in which temperature varies with height. If the temperature gets cooler with height, turbulence and vertical mixing will occur. If, however, the temperature gets warmer with height, turbulence is retarded and vertical mixing of pollutants will be retarded. Any layer characterized by increasing temperature with height is called an inversion. The following section presents a procedure for a simple and dramatic demonstration of the relationship between vertical temperature distribution and vertical mixing of pollutants.

Experiment I:

Demonstration: *Vertical Mixing and Vertical Temperature Distribution:*

The following procedure can be used as a demonstration by the instructor, or it can be performed as an experiment by students individually or in groups in a lab setting.

Materials:

3 large beakers (1,000 ml)
supply of ice (about 1 refrigerator tray)
supply of hot water (about 500 ml)
temperature 95 - 100 F
supply of water at room temperature
pack of cigarettes (a cigar or pipe will also do)
package of matches
one stop watch
rubber tube ($\frac{1}{4}$ -inch inside diameter, 12 inches in length)
Polaroid camera (optional)

Procedure: First, fill the three beakers halfway up: one with water at room temperature, one with ice water, third with hot water. Next, take rough measurement of the vertical temperature distribution. This can be done by measuring the temperature of water surface and of the air at about 1 foot above the water surface of each of the three beakers. Record results for each case. (See the sample chart.)

Example of data recorded during beaker dispersion experiment

Case	Water surface temperature	Temperature above beaker top (room temperature)	Vertical temperature changes	Dispersion time	Comments, observations
Hot water beaker	95°F	70°F	Strong decrease of temperature with height	1 minute	Immediate rapid mixing. Up and downdrafts visible
Room-temperature beaker	70°F	70°F	No temperature change with height (isothermal)	2.5 minutes	Up and downdrafts made visible by smoke, but slower than for hot water case.
Ice water beaker	33°F	70°F	Strong increase in temperature with height (inversion)	6.5 minutes	Dispersion slow. Distinct boundary visible between smoke and clean air. Wave-like movements seen at boundary.

Now we can test the mixing potential of the three mini-atmospheres. First, the hot water beaker (strong temperature decrease with height). Light cigarette. Place one end of the rubber tube just above the water surface in the beaker. Take a puff of smoke into your mouth and gently exhale the smoke into the other end of the rubber tube so that it travels into the beaker above the water surface. Gently remove the tube. Have someone measure the time it takes the smoke to disperse from the beaker to the point where the smoke is no longer visible. The students should be instructed to watch the motions made visible by the smoke. For greatest visibility use a dark background and have students watch the beaker at eye level.

The procedure is then repeated using the ice water beaker (strong increase in temperature with height), and finally for the beaker with water at room temperature (little change in temperature with height). In each case, the "dispersion time" should be carefully recorded along with any observations the students make regarding the behavior of the smoke. Care should be taken to avoid placing the beakers directly in strong drafts or near ventilators.

Discussion. The mini-atmosphere over the hot water surface is characterized by a steep decrease in temperature with height and rapid vertical mixing. The mini-atmosphere over the ice water surface is characterized by a strong increase of temperature with height (an inversion) and by extremely slow vertical mixing. By repeating the experiment several times, students will be able to observe additional evidence of vertical motion. Over the hot water rapid upward and downward movements of air and swirling motions are made visible by the smoke. Students are amazed by the trapping of smoke in the case of the ice water beaker -- often the smoke has a well-defined upper limit. Vertical movement is restricted to a gentle rolling motion visible at the interface between smoke and air.

After witnessing the beaker experiment, students often come away with the following impression: "the warmer the temperature, the more rapid the dispersion". To illustrate that the important variable is vertical temperature distribution and not merely the temperature, the instructor can set up or have the students set up a second experiment.

Experiment II

Take a moderate-size empty aquarium (1 x 1 x 2 feet would be about right). Chill the bottom of the aquarium for about 10 minutes using ice water (liberal on the ice). Empty the aquarium and set it upright so that the chilled bottom rests on the table. Using a rubber tube as in the beaker experiment, gently exhale cigarette smoke into the bottom of the aquarium. As expected, the smoke remains concentrated near the bottom for some time - temperature is increasing with height. Next, while the bottom is still cold, invert the aquarium so that the chilled bottom is now the top of the aquarium. Slip the rubber tube under the aquarium side and again blow smoke into the aquarium just over the table. Quickly and gently remove the tube (minimize the introduction of external turbulence and have the students watch the smoke). It mixes very rapidly through the whole depth of the aquarium, in marked contrast to the previous trial. In this case the cold surface was aloft causing a rapid temperature decrease with height -- despite the fact that we are working with the same chilled aquarium, nothing was heated.

Other variations can be attempted. Try heating the aquarium bottom. Repeat this experiment with the aquarium right-side up and then inverted. What happens? The aquarium demonstrations will help the students understand the importance of vertical temperature distribution in determining atmospheric stability.

Relating the Beaker Experiment to the Real Atmosphere

The above experiments can be used by the instructor to stimulate thought and discussion with regard to a number of questions. What does the experiment tell us about the real atmosphere? What situations are analogous to the hot- and cold-bottomed mini-atmospheres? A good example of a "hot-bottomed" atmosphere -- analogous to the hot water beaker -- frequently occurs on sunny afternoons. The sun heats the surface, warming the air close to the surface to a much greater extent than it warms the air aloft; the result is strongly decreasing temperature with height (afternoon sounding). Since the afternoon case is similar to the hot-water beaker case, we would expect strong vertical mixing to occur, and this is indeed the case. A "cold-bottomed" atmosphere, on the other hand, frequently occurs at night or early in the morning. During the night the surface gives off long-wave radiation and losing energy it cools in the process. Cooling at the surface is stronger than cooling aloft, and an inversion develops (the temperature increases with height). The early morning sounding represents an extremely stable atmosphere, one that retards vertical mixing; the pollutants emitted near the ground from cars, open burning, and other sources, would be trapped at relatively low levels.

Adapted with permission from the journal, The Science Teacher, September 1973.

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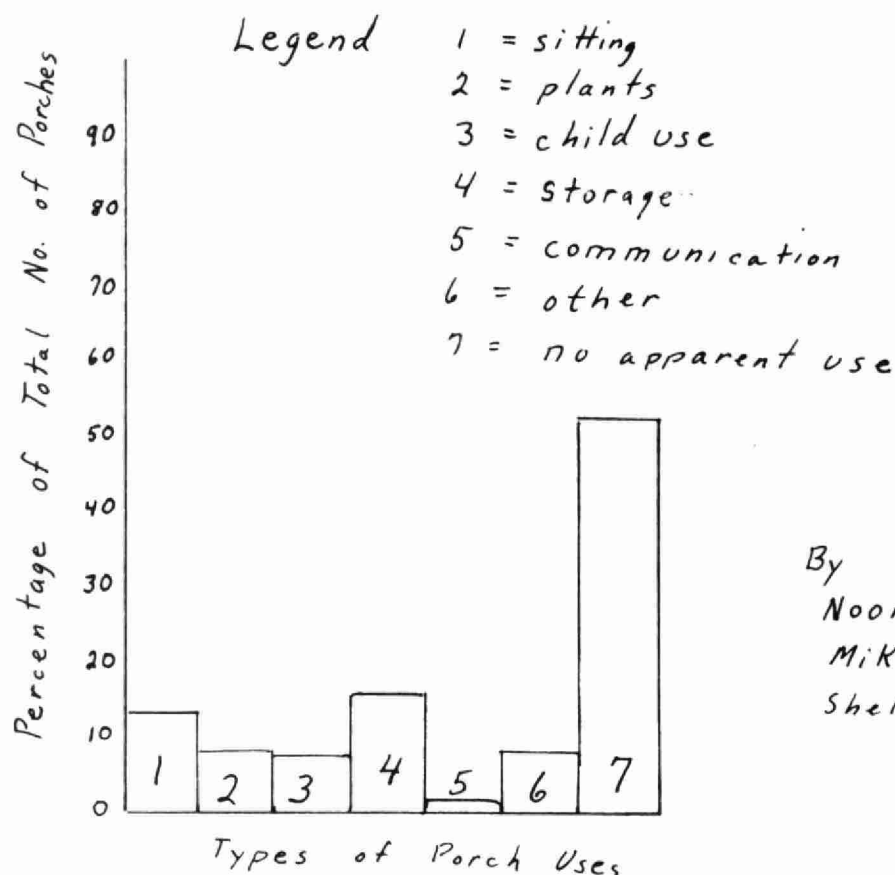
GEOGRAPHY AND THE COMMUNITY

The following unit of study was designed to help students learn geography by doing geography.

The local community is usually an untapped resource which, when utilized, is of benefit to both students and residents in the area. This particular unit has four sections to it. The following is a brief explanation of each section with some accompanying maps produced by Jarvis Collegiate students (grade 12) who recently completed this study in the Don Vale Community in Toronto.

1. Land Use

The students mapped all the general land uses, as well as collecting information that related to individual homes. How a family uses the area around their homes is often indicative of the "sense of community" that exists, and gives some clue as to the nature of the neighborhood (i.e. ethnicity, income). Figure 1, for example, indicate which house porches had evidence of being used for: 1) sitting, 2) plants, 3) child use, 4) storage, 5) communication - signs, 6) other, 7) no apparent use.



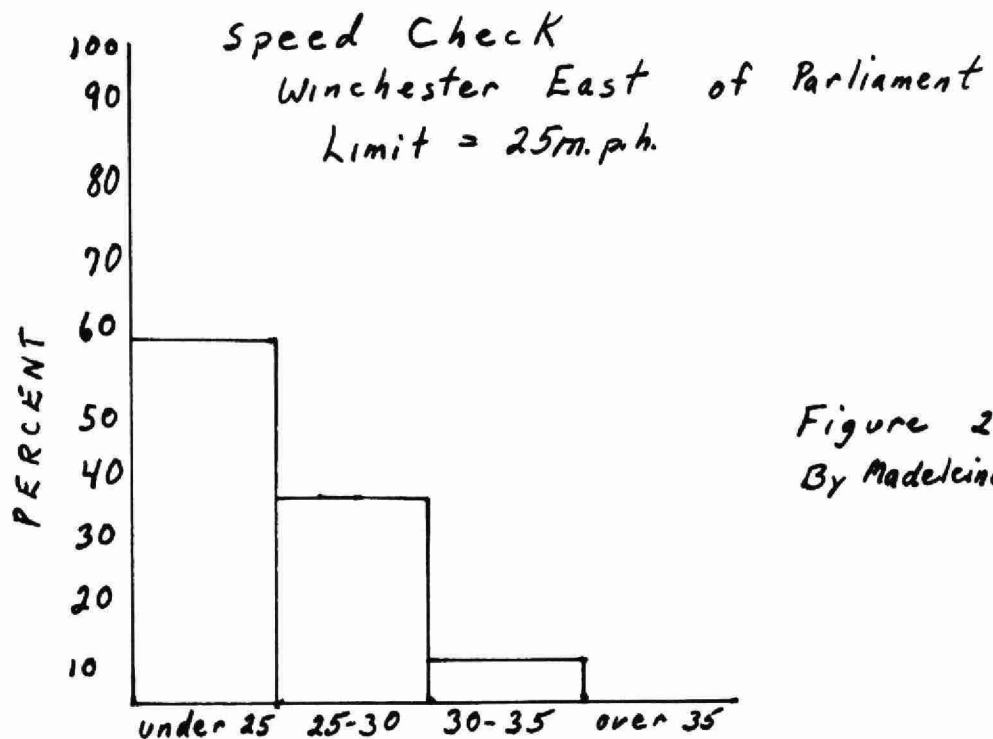
By
Noordin Jare
Mike Bolwell
Shelly Appleby

Figure 1

In a densely populated inner-city neighborhood, space is very valuable, and porches tend to be used more frequently than in suburban areas. In Don Vale, "sitting" was a common use. Students theorized that this, plus the short distance between homes and the front sidewalk, encouraged interaction between neighbors as well as with pedestrians passing by, making for a friendlier neighborhood.

2. Traffic

The students (a most dedicated group) rose at a very early hour to conduct a traffic count and a measurement of the speed of the vehicles using the local streets. The results were mapped, and problem areas became obvious. They were able to see shortcuts through the neighborhood, peak periods of travel and, as Figure 2 shows, the percentage of vehicles that were speeding.

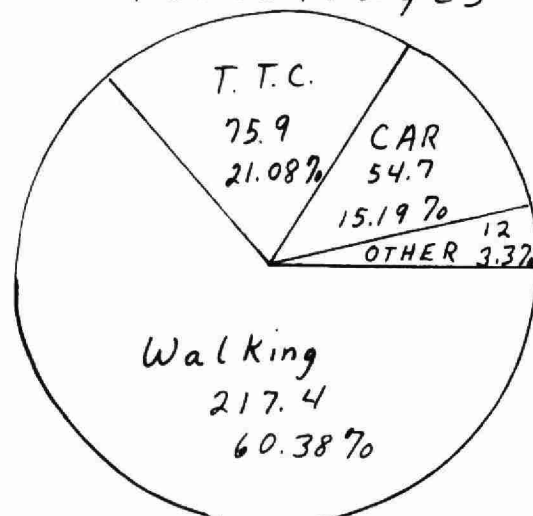


*Figure 2
By Madeline Rengelly*

3. Non-local land uses

Customers were interviewed at all the commercial establishments to determine where the customers lived, how often they used the store and how they travelled to it. Figure 3 indicates the modes of transportation. From the data, the students determined which establishments tended to serve the local community and which depended upon a wider population for their clientele.

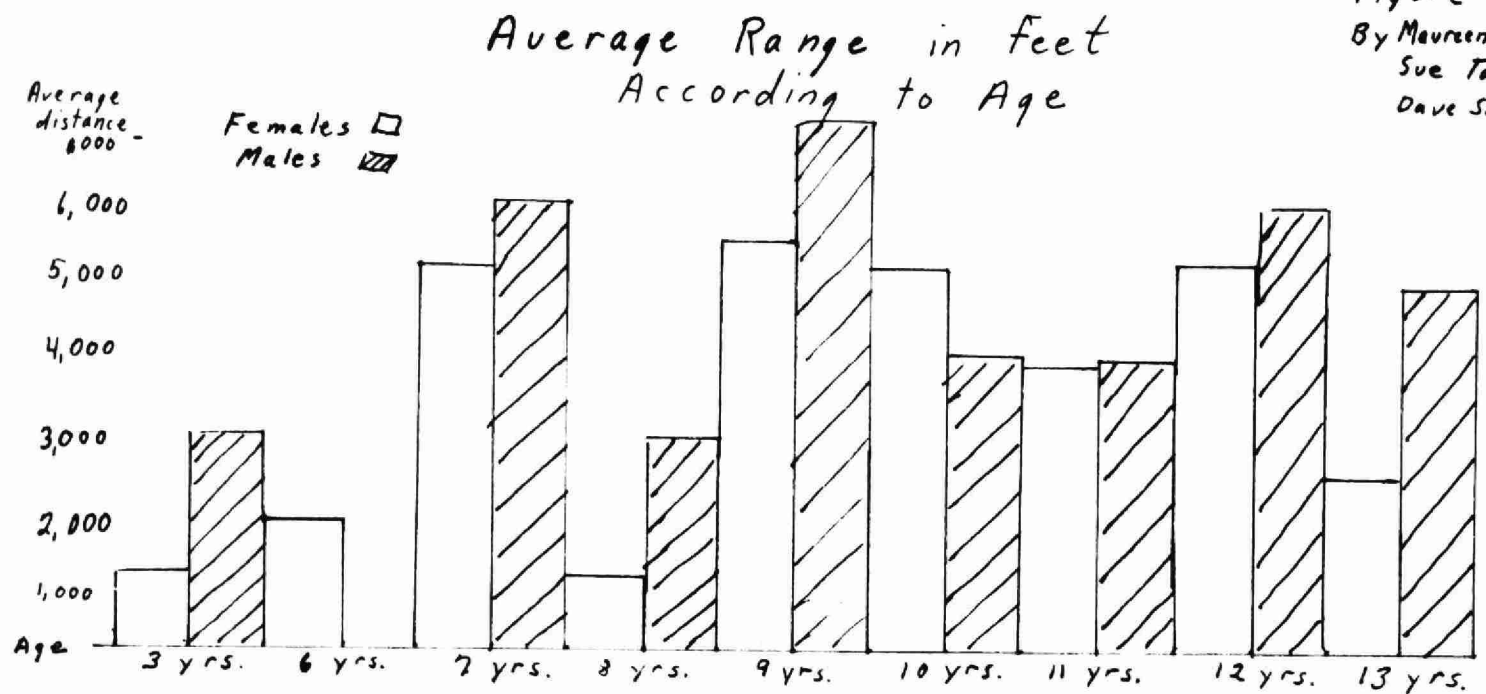
Local Vs Non-local Transportation Percentages



*Figure 3
By Monica Yapp*

How people get to the stores in this area

Figure 4
By Maureen Ballant
Sue Tatro
Dave Sawyer



4. Range of a child

Children were interviewed and asked questions related to where they play and roam throughout the neighborhood. This information was mapped and the child's "range" (distances travelled from home alone) was determined. Figure 4 is one graph of the results. The students found that "designated" play spaces were underutilized as children tended to play on roads, in alley ways and on front lawns. The group working on this study suggested various reasons for this:

- most of the "designated" play areas had restrictions on how the space was to be used (i.e. No ball playing allowed).
- traffic on the street surrounding the parks were the heaviest travelled routes in the neighborhood.
- and the park areas were concentrated in the east side of the community, not easily accessible to all children.

Finally, the students analyzed the individual studies together, looking for relationships, and suggesting alternatives to obvious geographical problems.

During the course of the unit, the students learned how to collect data, map information, conduct interviews, analyze figures, produce graphs and charts and most important, how to analyze real world problems and develop practical solutions.

Perhaps more important than these skills, the students now have some knowledge and appreciation of their own community. They probably learned more about the community by talking with the residents and simply walking through the neighborhood, than they did from the recorded data and subsequent analysis. On the other hand, the final maps and graphs may be of some use to the local residents.

Jarvis Collegiate was the sixth school in Toronto to experiment with the work. Many necessary changes have been made to the study since our first experiment last summer. A teacher's manual that explains how such a study can be carried out is now available.

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POLLUTION IN THE GREAT LAKES

A hundred thousand years ago, the huge Laurentide Ice Sheet began its outward push from northeastern Canada. This massive glacier, five to ten thousand feet thick, began to leave its mark on the surface of the earth. Yielding to the enormous weight, the earth's crust sank beneath its load.

As the Laurentide Ice Sheet melted some 10 to 15 thousand years ago it left behind what is considered the world's largest fresh water reservoir.

Today, these lakes play a key role in the economy of this continent supporting more than 35 million people around its shores. In Canada, about one-third of our entire population is centred around the Great Lakes.

From the time they were formed, the lakes began to fill with sediment from inflowing streams. This sediment provided the nourishment for the growth of aquatic plants. These plants in turn trap additional sediment. Many thousands of years from now as this natural cycle continues, and as the earth's crust slowly continues to rebound from the pressure of the ice age, the Great Lakes, like all of the world's lakes, will ultimately disappear.

Unfortunately, man has accelerated this natural action. Since the arrival of the first settlers and the growth of population around the Great Lakes, the input of phosphorus and other nutrients into the lakes has increased with the most pronounced increase occurring over the past few decades. These chemicals are contained primarily in municipal sewage, industrial wastes, and in farm fertilizers. On farms, such chemicals are used to grow abundant crops. In the lakes, they have the similar effect of increasing aquatic growth.

Canada/Ontario Agreement

Recognizing the need for immediate action to control the deterioration of the Great Lakes, Ontario signed an agreement with the Government of Canada -- The Canada-Ontario Agreement on Lower Great Lakes Water Quality (1971). Under this Agreement, a cost-sharing plan between the federal government and Ontario made finances available to municipalities for the construction of phosphorus removal facilities to two hundred affected sewage treatment plants in southern Ontario.

In 1972, the Canada-United States Agreement on Great Lakes Water Quality was signed to improve water quality in the Great Lakes and to protect the lakes from further pollution in the future. Under this Agreement, the States bordering the Great Lakes were brought into the plan of action for installing phosphorus removal facilities in sewage treatment plants.

Phosphorus removal equipment has been and still is a major weapon in the fight against environmental deterioration of the Great Lakes. Ontario has spent approximately \$480 million on municipal sewage treatment facilities with a further \$400 million committed for further projects. This equipment has been installed in all treatment plants in southern Ontario which provide significant discharges to the Great Lakes.

Industry has also played a substantial role in this battle. The Ontario Ministry of the Environment has worked closely with the industrial sector in planning abatement programs for pollution control. To date, in excess of \$250 million have been spent by industry for abatement programs for pollution control and every major industry in the Province is engaged in these programs.

As a result of these and other actions, the deterioration of the Great Lakes caused by excessive nutrient loadings has been curbed and the trend reversed.

Additional Concerns

There have been some delays by the United States in meeting the deadlines for phosphorus removal. However, funds authorized for municipal treatment plants have been released and the U.S. Environmental Protection Agency has placed high priority in meeting the water quality objectives set out under the Canada-U.S. Agreement.

However, the battle has only just begun. In the last few years, serious toxic contaminants have surfaced in the Great Lakes. For example, DDT, Mercury, Asbestos, PCBs, and Mirex. Effective technological processes have now been developed to detect, measure and assess the impact of these contaminants.

In many cases, the major sources of these contaminants have been isolated and abatement programs developed to stop further contamination. In addition, laws have been developed both at the federal and provincial levels to control the entry of these toxic substances to our environment.

Legislation

In late 1975, the Government of Canada passed The Environmental Contaminants Act and on April 1, 1976, it was proclaimed by the Governor General of Canada. The intent of this legislation is to regulate the introduction, use, distribution and processing of materials in quantities greater than 225 kg. per year. Under this Act, an Environmental Contaminants Board of Review will investigate any substances suspected of constituting a danger to human health or the environment.

In Ontario, similar action has been taken with the passing of the new Environmental Assessment Act. Under this Act, new developments which might be significant to our environment will have to be assessed at the conceptual stage. In this assessment, all effects on our natural, social, economic, cultural and physical environment will be considered.

As can be seen from these two pieces of legislation, the primary objective is prevention of future contamination. But future strategies also include co-ordinated research and pollution control activity between Canada and the U.S. Much of this is co-ordinated through the International Joint Commission.

Founded in 1909, under the Boundary Waters Treaty, the International Joint Commission plays an important role in co-ordinating the efforts of the two countries. Data obtained from research is accumulated by the Commission which in turn assesses the need for remedial action and presents its recommendations to both governments.

This co-ordination of planning and the implementation of recommendations is of utmost importance to the prevention of further pollution of the Great Lakes caused by continuing population growth, resource development and increasing use of water.

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Other Sources:

International Joint Commission
Great Lakes Regional Office
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Windsor, Ontario N9A 6T3

Fisheries and Environment Canada
Information Services Directorate
Ottawa, Ontario K1A 0H3

Questions

1. The Great Lakes have been labeled as the keys to Canada. Is this title justified?
2. Describe the natural aging process of a lake. Will the Great Lakes undergo this process?
3. What is meant by the term "eutrophication"?
4. Phosphorus increased the aquatic plant growth within a lake. Where does the phosphorus come from and what is the effect of this excessive plant growth on the lake ecosystem?
5. Of all the Great Lakes, Lake Erie is said to be the most polluted, while Lakes Superior and Huron are the least polluted. What are the reasons for this?
6. The first settlers did not use chemical fertilizers or other artificial compounds to protect their land and crops but they can be blamed for some of the deterioration of the water quality of the Great Lakes. Can you explain this?
7. Imagine you are an ex-soldier, who has bought 50 acres of land with water frontage on Lake Ontario. The land is completely forested and you must clear part or all of the area for 1) a log cabin, 2) a barn, 3) an outhouse, 4) root house (used for storing preserves, vegetables, and fruit), 5) a small dairy building, 6) a fruit and vegetable garden, and 7) at least 30 acres for your crops of oats, corn, pumpkins, potatoes, wheat and rye. Taking into account any potential sources or causes of pollution, sketch your homestead using a scale of 1 inch = 5 acres.

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A LESSON PLAN FOR INVESTIGATING ENVIRONMENTAL HABITATS

Set the stage for this investigation by reviewing quickly what will take place in the allotted time. For example: In the next 4 hours we will investigate several environmental habitats, infer how animals fit into food chains and energy cycle and how they are important to the environment, record changes in habitats, and discuss what we can do as citizens to improve the biological interactions in our environment. You might want to read the behavioral objectives which appear at the end of this lesson plan and refer back to them as an evaluation of session.

I. OBSERVING AND MEASURING ANIMAL SIGHTINGS AND EVIDENCES

Questions and discussion (10 minutes):

1. What animals would we expect to find living in this area (vertebrate, invertebrate)?
2. What are the needs of these animals?
3. What are some names of the place where animals live?
4. Where would you look for animals around here?
5. Describe and pass out TASK A and B cards.

TASK A: (30 minutes) Work in small groups.

1. Explore as many places (environments or habitats) as you can from (point out boundaries) _____ to _____, and record animals that you see or any evidence of animals. As you inventory the animals or their evidences, figure out some way of recording *amounts* of evidences and animals seen.
 2. Look for and list evidence (signs) of animals (partly consumed foods, excrement, homes, bird nests, feather, etc.)
 3. Observe and list different habitats for wildlife in area. (Grass, cultivated field, hedges, swamp, etc.)
 4. Observe and list animal foods in area:
-
-

TASK B: (30 minutes) Work in small groups.

Select three different habitats and compare the numbers of animal organisms and the characteristics in each.

Habitat I

Habitat II

Habitat III

Characteristics
of habitat I

Characteristics
of habitat II

Characteristics
of habitat III

Questions and discussion:

1. What animals did you find in each habitat?
2. Which habitat had the most animals? Why?
3. What were the characteristics of each habitat?
4. What could account for the differences and similarities of the habitats?
5. What factors made one habitat more desirable than another?
6. Pass out TASK C cards.

TASK C: (15 minutes)

Build a food pyramid showing the comparative amounts of animal and animal evidences seen.

Questions and discussion (15 minutes):

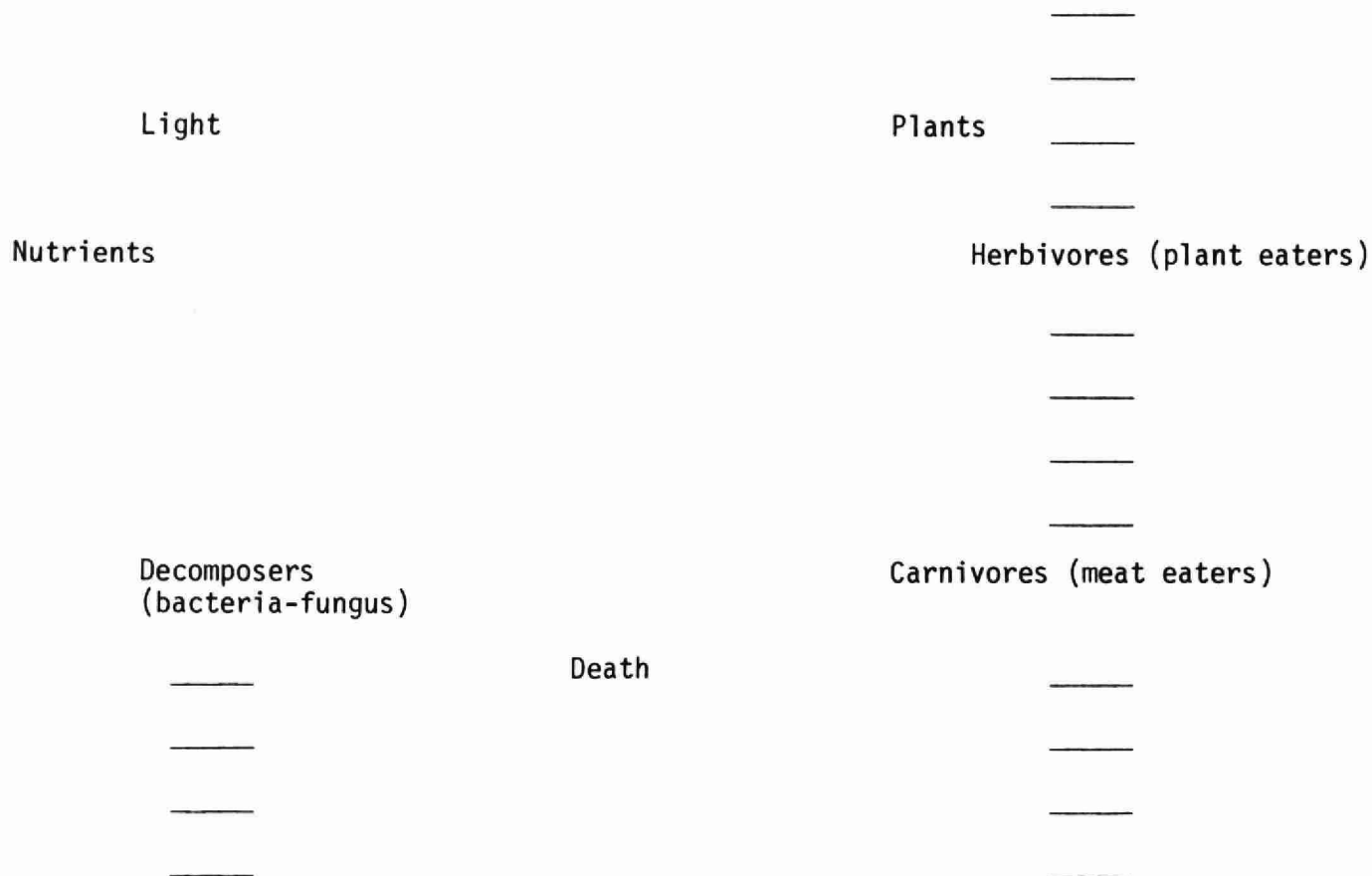
1. What did you find?
2. How many habitats did you investigate?
3. Which animals around here have the largest habitat? The smallest?
4. What was the largest group of animals found?
5. What do you think their main function in the environment might be?

Discuss terminology and definitions of herbivores, carnivores, omnivores, decomposers.

Pass out TASK D cards.

TASK D: (10 minutes)

List the animals you have seen or their evidences in the appropriate places in this diagram. Use arrows to show direction of relationships, i.e.: energy flows from the sun to living things; plants support herbivores. What other words and ways can you think of to illustrate a similar cycle? Some people call this the energy cycle.



What would happen if one group were eliminated?

If _____ group was eliminated, I think the following would happen:

Questions and discussion (5 minutes):

1. What is the function of each part of the energy cycle?
2. What would happen if the decomposers were removed from this ecosystem?
3. How does the energy cycle relate to a food chain?
4. What is a food chain? (Or, who eats whom?)

Pass out TASK E cards.

TASK E: (10 minutes)

Construct a 5-stage food chain using specific animals seen so far.

II. OBSERVING AND RECORDING CHANGES IN ANIMAL HABITATS

Questions and discussion (10 minutes):

1. How did your food chain relate to the energy cycle in TASK D?
2. What is the difference between food chain and food web?
3. Look at your food chain and see if you can construct a web out of it.
4. What evidences of influences can you name that have affected this environment?

Pass out TASK F cards.

TASK F: (20 minutes)

Describe in writing, 3 influences you have discovered that have changed the habitats in this area including the cause and effect relationships that occurred.

Consider:

- a. Evidence of change and the influence or factor causing it.
 - b. What area probably looked like before change occurred and animals that lived then.
 - c. What area looks like now and animals that live here now.
 - d. How the change affected the habitat and animal species that did and do live there.
-

Questions and discussion (10 minutes):

1. Have individuals read their descriptions, and compare different descriptions.
 2. What evidences did you find that show man's influence in this area?
-

III. COMMUNICATING FEELINGS, AWARENESS, AND VALUES ABOUT THE ENVIRONMENT

TASK G: (10 minutes)

Describe how you *feel* about man's effect on one animal habitat you observed.

Questions and discussion:

1. Discuss results of TASK G with group.
 2. What are some things that man has done to effect the efficiency of the energy cycle? Here? Elsewhere?
-

TASK H: (15 minutes)

Describe in writing, three things you can do in your everyday life to make the energy cycle more efficient and cause the least amount of harm to the ecosystem.

Select the one you think would be your best contribution. Describe the benefits of this action.

- a. Where you live
 - b. In your consumer habits.
-

Discuss Results of TASK H.

Summary Questions:

1. What did we find out about animals in our field study session today?
 2. Why are animals important in the ecosystem?
 3. How can we summarize our investigations today?
 4. What processes and methods did we use to find these things out?
 5. Which of the behavioral outcomes did we accomplish in this session? (Read and discuss).
 6. How has man been part of this ecosystem?
 7. How does this area fit into the larger scheme of things?
-

TASK I:

Describe in writing how you feel about our session today.

Behavioral Outcomes in Knowledge

After this session you should be able to:

- Identify four basic functions about each environment.
- Describe three ways in which the environments are interrelated.
- Identify three factors common to the environments.
- Describe three similarities and differences between each environment.

Behavioral Outcomes in Attitudes, Awareness, Values, and Action

- Describe at least two unique contributions that each environment makes to society.
- Identify at least three guidelines that you would use in planning for management of the environments.
- Describe how you feel about man's use of each environment.
- Describe your recommendations for the future management of the area.

This lesson plan was originally prepared by the U.S. Dept. of Agriculture, Forest Service, Environmental Education Branch, Washington, D.C. 20250, and appeared in the publication "Teaching Materials for Environmental Education".

DEFINITIONS

Ecosystem: a living community of plants and animals and the environment in which they exist and affect each other.

Environment: the surroundings of all living and non-living things.

Habitat: The place where an animal or plant lives. An animal's habitat is where it finds its food and shelter and where it carries on its activities. Many different plants and animals may share the same habitat.